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Original Article

Dead or Alive? Knowledge about a Sibling's Death Varies by Genetic Relatedness in a Modern Society

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Abstract: Using a large sample of non-institutionalized individuals from the Netherlands ($n = 7610$), we examined the influence of relatedness on an individual's knowledge about whether their sibling is alive or not. Respondents were generally less likely to know whether their sibling was alive if they were not fully related. The effects were stronger for differences between paternal half-siblings and full siblings than for differences between maternal half-siblings and full siblings.

Keywords: kin selection, siblings, human family, death, social cognition

Introduction

From a kin selection perspective (Hamilton, 1964), relatedness is predicted to have a strong impact on family interactions, even in modern societies (Emlen, 1995, 1997). Evolutionists have thoroughly examined the influence of genetic relatedness on human parent-offspring relations (Daly and Wilson, 1981, 1982, 1985, 1988). Several studies have also investigated the role of biological kinship for altruism between individuals (e.g., Korchmaros and Kenny, 2001; Madsen et al., 2007) but the role of relatedness for investment between sibling has been relatively unstudied. With regards to the study of siblings, evolutionists have mainly focussed on sibling rivalry (Sulloway, 1996, 2001), sibling differentiation (Dunn and Plomin, 1991; Plomin and Daniels, 1987) and cues to incest avoidance (Bevc and Silverman, 1993, 2000; Lieberman, Tooby, and Cosmides, 2003; Fessler and Navarrete, 2004). In comparison, relatively little attention has been paid

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to studying actual investment between siblings. Emlen (1997) suggested however that individuals will invest more in, and have closer relationships with, full siblings than half-siblings or stepsiblings. There is some evidence for this prediction: both parents and children report more conflict between siblings when siblings are not fully related (Hetherington, 1988; Aquilino, 1991 for review, but see Kim, Hetherington, and Reiss, 1999). Adult siblings also appear to invest more in fully related siblings than in half-siblings (Pollet, 2007). Even when a society places a strong emphasis on treating all siblings equal, regardless of their relatedness, siblings display more solidarity when fully related (Jankowiak and Diderich, 2000). Here, we examine whether relatedness affects basic knowledge about whether or not a sibling is alive in a cohort of Dutch adults.

Knowledge about whether a related individual is alive or not is required in order to invest in them, and siblings who do invest will consequently have knowledge of their current state. Our hypothesis is that respondents will be more likely to know whether a sibling is alive when they are fully related than when they are not. It is important to bear in mind that this hypothesis is at the ultimate level (Tinbergen, 1963), we are not testing which proximate mechanisms regulate investment in kin.

One could argue that growing up together, rather than genetic relatedness per se, knowledge about a siblings' death. Identity theory (Stets and Burke, 2000) suggests that individuals who growing up together will learn to identify themselves as members of the same family. This proximate theory would suggest that relatedness in most families is confounded with being raised together. This confound of childhood co-residence can be distinguished from relatedness by comparing not only paternal half-siblings with full siblings but also maternal half-siblings with full siblings. Maternal half-siblings are brought up together just like full siblings, in contrast to paternal half-siblings (De Graaf, 1997; Pollet, 2007). If we find a consistent difference between maternal half-siblings and full-siblings, this suggests that genetic relatedness independently influences knowledge about a sibling's death. The scenario proposed by identity theory would not hold in this case.

Materials and Methods

The first wave of the Netherlands Kinship Panel Study (NKPS) dataset was obtained through the Netherlands Interdisciplinary Demographic Institute (NIDI). The NKPS is a large scale longitudinal study, designed to investigate family and kin relations in the Netherlands (Dykstra et al., 2004). The first wave was completed mid-2004; we used the most recent version of the first wave dataset for this study (version of 21-7-05; main sample). The sampling procedure, representativeness, variables and survey method are described in detail by Dykstra and colleagues (2004). In the NKPS, respondents are asked to list all their siblings (adopted, step, half- and full siblings) and to indicate whether they know whether this sibling is alive or not. For each half-sibling we coded whether they were paternal or maternal. No data are available on whether stepsiblings are maternal or paternal. Given the small numbers of adopted siblings (<1%), these were excluded from analyses. Our analyses thus contained four categories for sibling type (full sibling (FS), maternal half-sibling (MHS); paternal half-sibling (PHS); stepsibling (SS)). In this sample, if the parents of the respondent split up, the respondent virtually always remains in a family structure containing their biological mother rather than remaining in a family structure containing their biological father (Pollet, 2007). Thus, maternal half-siblings, like full

siblings, are raised together, whereas paternal half-siblings are not.

We present data for the first six siblings. The vast majority (95.3%) of the total sample of respondents with siblings has six or fewer siblings. Starting from the seventh sibling, sample size becomes increasingly small for constructing multinomial logistic regression models (MLR's). For these six siblings we constructed separate multinomial logistic regressions in order to investigate the independent effect of sibling type on knowledge about the sibling's death (Hosmer and Lemeshow, 1989; Menard, 1995; Pampel, 2000; Peng, Lee, and Ingersoll, 2002). Multinomial logistic regression is used to predict outcome variables of a categorical nature. It is relatively free of assumptions and statistically robust. Parameters are estimated by maximum likelihood. As a parameter selection procedure, we used forward stepwise. Model outcomes were the same in terms of model fit and Nagelkerke R^2 (Nagelkerke, 1991) when backward stepwise was used instead. Besides relatedness, we entered the following control variables in our analysis: education (9 categories: from incomplete/primary to university/postgraduate; treated as interval), age, age differences between the siblings, gender of the respondent, and number of family transitions before age of 16. A family transition refers to an alteration in the respondent's family living situation since birth, for instance going to live with grandparents or with another family member (see Dykstra et al., 2004 for more info on these variables). Missing values on these variables were deleted listwise. The descriptives for the sample are listed in Table 1.

For each of the models we present odds ratios, Wald statistics and p values for the likelihood ratio tests (p_{LLR}). The odds ratio gives the relative odds of not knowing whether the sibling is alive if the independent variables are changed in the specified way (e.g. a different sibling type). Odds ratios for the control variables are not reported here and can be obtained from the author. The Wald statistic is used to test whether an odds ratio differs significantly from 1 (Pampel, 2000). The p_{LLR} for each variable is based on the difference in model fit (-2LogLikelihood ; Pampel, 2000) between a model with the variable and one without, and is thus a measure of significance of effect of each independent variable. The Nagelkerke R^2 is a measure of variance explained by the overall model.

Results

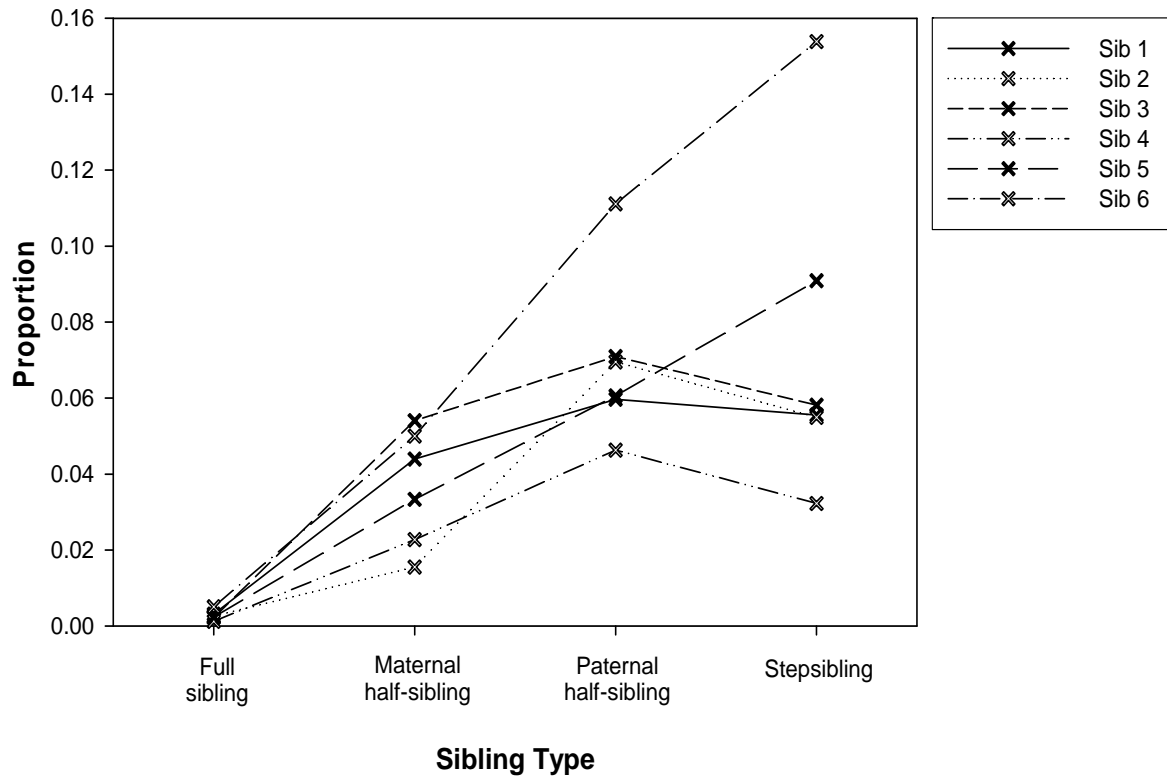
Table 1 shows the descriptive statistics for the sample.

Table 1. Descriptive statistics for the sample.

Variables	Categories	Frequencies/means
Educational attainment of respondent	Incomplete primary or primary	<i>n</i> = 684
	Lower vocational	<i>n</i> = 1117
	Lower general secondary	<i>n</i> = 896
	Medium general secondary	<i>n</i> = 389
	Upper general secondary	<i>n</i> = 325
	Intermediate vocational	<i>n</i> = 1678
	Higher vocational	<i>n</i> = 1775
	University or postgraduate	<i>n</i> = 746
Gender of the respondent	Male	<i>n</i> = 3168
	Female	<i>n</i> = 4442
Sibling type (sib 1)	Full sibling	<i>n</i> = 7295
	Maternal half-sibling	<i>n</i> = 91
	Paternal half-sibling	<i>n</i> = 134
	Step-sibling	<i>n</i> = 90
Age	(interval)	<i>Mean</i> = 33.48 years (<i>SD</i> = 8.6 years)
Family transitions	(interval)	<i>Mean</i> = 0.06 (<i>SD</i> = 0.33)
Number of siblings (full, half-, and step-)	(interval)	<i>Mean</i> = 3.36 (<i>SD</i> = 2.55)
Age difference (sib 1)	(interval)	<i>Mean</i> = -3.33 (<i>SD</i> = 6.28)

Figure 1 represents the proportion of individuals that does not know whether their sibling is alive by sibling type.

Figure 1. Proportion of respondents that does not know whether their sibling is alive or not by sibling type.



The regression models and odds ratios are represented in Table 2. The Nagelkerke R^2 varied between 0.162 and 0.34, which is good according to standards in the social sciences. Across all six models, sibling type proves to be a highly significant predictor of knowledge about a sibling's death ($p_{llr} < 0.001$). The other variables did not prove consistent predictors. Across the six models, odds ratios for SS versus FS, PHS versus FS, and MHS versus FS were all significant, with a strong effect size (varying between 5.36 and 42.4). For instance, respondents are 25.75 times more likely to not know whether their sibling 1 is alive when sibling 1 is a SS than when he/she is a FS. Odds ratios were generally stronger for SS versus FS (15.9 - 42.4, mean 27.57) and PHS versus FS (13.03 - 36.74, mean 25.4), than for MHS versus FS (5.36 - 23.56, mean 11.95). However, the direct comparisons of PHS to MHS and SS to MHS produced only one significant odds ratio each.

Table 2. Model overview for MLR, p_{LLR} and odds ratios. n = number of respondents in analysis.

		Sib 1	Sib 2	Sib 3	Sib 4	Sib 5	Sib 6
n		7610	5834	3994	2710	1829	1269
Model	Nagelkerke R^2	0.162	0.22	0.233	0.341	0.208	0.25
Variables (p_{LLR})	Age	***	*	n.s.	n.s.	n.s.	n.s.
	Gender	n.s.	*	n.s.	n.s.	n.s.	n.s.
	Education	n.s.	n.s.	*	n.s.	n.s.	n.s.
	Number of sibs	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
	Family transitions	*	n.s.	n.s.	n.s.	n.s.	n.s.
	Age difference	**	n.s.	n.s.	***	n.s.	**
	Sibling type	***	***	***	***	***	***
Odds ratios (sibling type)	SS vs FS	18.76***	32.96***	32.51***	15.9**	42.4***	24.41***
	PHS vs FS	13.03***	35.15***	36.79***	22.87***	27.36***	17.21***
	MHS vs FS	10.02***	5.36*	23.56***	8.92†	14.62*	9.2*
	PHS vs MHS	n.s.	6.56*	n.s.	n.s.	n.s.	n.s.
	SS vs MHS	n.s.	6.15*	n.s.	n.s.	n.s.	n.s.
	SS vs PHS	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Odds ratios	Age difference	1.05**	n.s.	n.s.	1.1***	n.s.	1.07**

Note. Odds ratios for comparisons between sibling types. †: $0.1 < p < 0.05$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$ (Wald statistic for odds ratios). n.s. = not statistically significant.

Discussion

Relatedness influenced an individual's knowledge about the death of a sibling: respondents who were fully related were significantly more likely to have this basic knowledge about their siblings than individuals who were not fully related. Other variables such as gender or age of the respondent did not consistently influence this knowledge. Given that there are consistent differences not only between PHS and FS, but also between MHS and FS, in knowledge about a sibling's death we can conclude that genetic relatedness in itself influenced this knowledge. Childhood co-residence cannot account for the observed differences between maternal half-siblings and full siblings, as in both cases siblings are raised together. Thus, we find support for Emlen's prediction (1997): full siblings tend to have closer relationships than half-siblings or step-siblings.

This study dealt with an ultimate question and did not examine the proximate mechanisms regulating kin investment in detail. An obvious proximate mechanism that can explain the observed difference between PHS and FS and between SS and FS is childhood co-residence. Both evolutionary theory and identity theory lead to suggest that being raised together should be an important cue to kinship. For example, childhood co-residence plays a very important role for incest avoidance (e.g., Bevc and Silverman, 2000; Lieberman et al., 2003). Childhood co-residence can also be linked to the recently suggested role of the maternal perinatal association (MPA), seeing your mother in close association with your sibling, for kinship detection (Lieberman, Tooby, and Cosmides, 2007). We are not

suggesting that childhood co-residence and/or MPA is the only kinship cue governing investment but it is likely to be a very important one. Childhood co-residence and/or the MPA, however, cannot explain the differences between full siblings and maternal half-siblings. It is likely that a cue such as third party knowledge, somebody telling an individual that he or she is a fully related sibling to another person, might be important here. However, such a cue can definitely be the sole cue regulating sibling investment: the differences between PHS and FS and SS and FS were far stronger than those between MHS and FS. This indicates that being raised together and the maternal perinatal association are likely to be important cues in determining later investments. Thus, multiple kinship cues affect basic knowledge about a sibling's death. Further research is however necessary to disentangle the relative importance of each kinship cue and how they interact in kin detection.

The direct comparisons of SS and MHS, and PHS and MHS were not consistently significant. This is likely due to the small number of cases under comparison. Larger samples are necessary to further explore the relative importance of relatedness compared to being raised together.

In conclusion, as kin selection theory (Hamilton, 1964) and Emlen (1997) lead to predict, genetic relatedness strongly affects an individual's knowledge about whether a sibling is alive or not. Individuals were significantly more likely to have basic knowledge about their sibling when fully related, and such knowledge is likely to be symptomatic of their ongoing investments in that relationship.

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